

PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of

Toshiki KOSHIMAE, et al.

Appln. No.: Not Yet Assigned

Confirmation No.: Not Yet Assigned

Group Art Unit: Not Yet Assigned

Filed: January 28, 2002

Examiner: Not Yet Assigned

For: SOLID-STATE LASER DEVICE

PRELIMINARY AMENDMENT

Commissioner for Patents
Washington, D.C. 20231

Sir:

Prior to examination, please amend the above-identified application as follows:

IN THE SPECIFICATION:

Page 2, please delete the paragraph bridging pages 1 and 2, and replace it with the following new paragraph:

Fig. 9 is a schematic diagram showing a structure of a portion where the solid laser medium (hereinafter referred to as a laser medium, as needed) 2 is excited by the laser diode 1. A plurality of laser diodes 1 (1a, 1b, 1c and 1d) are connected in series to a direct current power source 10, and apply excitation light to the cylindrical laser medium 2 via a light guide 11. The excitation light may be applied directly to the laser medium 2 without using the light guide 11. Since a current is used to control the output of the laser diode 1, a direct current power source for controlling the current is frequently employed as the direct current power source 10.

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Page 5, please delete the second full paragraph, and replace it with the following new paragraph:

According to the present invention, there is provided a solid-state laser diode comprising:

a laser diode for exciting a solid laser medium;
a constant current source for supplying a constant current to the laser diode;
voltage measurement unit for measuring a voltage at both ends of the laser diode; and
abnormality detection unit for detecting an abnormality at the laser diode based on an output of the voltage measurement unit.

Page 6, please delete the first full paragraph, and replace it with the following new paragraph:

Further, according to the present invention, there is provided a solid-state laser device comprising:

a plurality of laser diodes connected in series, for exciting a solid laser medium;
a constant current source for supplying a constant current to the laser diodes;
voltage measurement unit for measuring the voltage at both ends of the laser diodes; and
abnormality detection unit for detecting an abnormality at the laser diodes based on the output of the voltage measurement unit.

Page 7, please delete the first full paragraph, and replace it with the following new paragraph:

In addition, according to the present invention, there is provided the solid-state laser device, wherein when n (n is a natural number equal to or greater than four) laser diodes are

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connected, the voltage measurement unit measures the voltages of sets including m laser diodes (m is a natural number smaller than n) individually to output the voltages to abnormality detection unit.

Page 7, please delete the third full paragraph, and replace it with the following new paragraph:

Furthermore, according to the present invention, there is provided the solid-state laser device, wherein a normal range having a finite width defined an upper limit value and a lower limit value as reference values of the voltage for determining abnormality of the laser diode is set; and when the voltages at the laser diodes measured by the voltage measurement unit are equal to or higher than the upper limit value or equal to or lower than the lower limit value, the abnormality detection unit outputs an abnormality detection signal.

Page 8, please delete the second full paragraph, and replace it with the following new paragraph:

Moreover, according to the present invention, there is provided the solid-state laser device further comprising:

reference value change unit for changing the normal range for the measured voltage set at the abnormality detection unit on a basis of an input current value.

Page 10, please delete the paragraph bridging pages 9 and 10, and replace it with the following new paragraph:

Fig. 1 is a diagram showing a structure of an essential portion of a solid-state laser device according to a first embodiment of the present invention. A laser diode 1 is connected to

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a direct-current power source 10. Excitation light emitted from the laser diode 1 is applied to a solid-state laser medium 2. Further, a wiring for measuring the voltage of the laser diode 1 is installed in the laser diode 1 and the voltage of the laser diode 1 is measured by a voltage measurement unit 12. The voltage measured by the voltage measurement unit 12 is transmitted to a fault determination unit 13, which is as an abnormality detection unit, to be compared with an upper limit value and a lower limit value that are set in advance. When being determined a fault, the fault determination unit 13 outputs a fault signal.

Page 18, please delete the paragraph bridging pages 17 and 18, and replace it with the following new paragraph:

Fig. 6 is a schematic diagram showing a structure of the fault determination unit when the voltage range for a determination of normality varies depending on an input current. The voltage at the laser diode 1 is changed depending on the current flow. At a fault determination unit 43 in Fig. 6, based on the value of the input current, the upper limit value V2 to be input to an upper voltage limit comparison unit 43a and the lower limit value V1 to be input to a lower voltage comparison unit 43b are changed by an upper limit value change operation unit 43c and a lower limit value change operation unit 43d, which are reference value change unit, respectively. In this case, the voltage range for the determination of normality is shown in Fig. 7.

IN THE CLAIMS:

Please enter the following amended claims:

1. (Amended) A solid-state laser diode comprising:
a laser diode for exciting a solid laser medium;
a constant current source for supplying a constant current to the laser diode;

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voltage measurement unit for measuring a voltage at both ends of the laser diode; and
abnormality detection unit for detecting an abnormality at the laser diode based on an
output of the voltage measurement means.

2. (Amended) A solid-state laser device comprising:
a plurality of laser diodes connected in series, for exciting a solid laser medium;
a constant current source for supplying a constant current to the laser diodes;
voltage measurement unit for measuring the voltage at both ends of the laser diodes; and
abnormality detection unit for detecting an abnormality at the laser diodes based on the
output of the voltage measurement unit.

3. (Amended) The solid-state laser device according to claim 2, wherein the
voltage measurement unit measures the voltage of the plurality of laser diodes individually to
output the individual measured voltage to the abnormality detection unit.

4. (Amended) The solid-state laser device according to claim 2, wherein when n
(n is a natural number equal to or greater than four) laser diodes are connected, the voltage
measurement unit measures the voltages of sets including m laser diodes (m is a natural number
smaller than n) individually to output the voltages to abnormality detection unit.

5. (Amended) The solid-state laser device according to claim 1, wherein a normal
range having a finite width defined an upper limit value and a lower limit value as reference
values of the voltage for determining abnormality of the laser diode is set; and

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when the voltages at the laser diodes measured by the voltage measurement unit are equal to or higher than the upper limit value or equal to or lower than the lower limit value, the abnormality detection unit outputs an abnormality detection signal.

6. (Amended) The solid-state laser device according to claim 5, further comprising:

reference value change unit for changing the normal range for the measured voltage set at the abnormality detection means on a basis of an input current value.

IN THE ABSTRACT OF DISCLOSURE:

The abstract is changed as follows:

According to the present invention, there is provided a solid-state laser diode comprising:

a laser diode for exciting a solid laser medium;

a constant current source for supplying a constant current to the laser diode;

voltage measurement unit for measuring a voltage at both ends of the laser diode; and

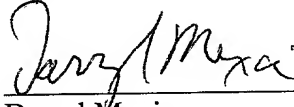
abnormality detection unit for detecting an abnormality at the laser diode based on an output of the voltage measurement unit. Whereby a photodiode need not be arranged on the periphery of the solid laser medium and the laser diode, and an abnormality at the laser diode can be detected without increasing the size of the device and complicating the device and without deteriorating the laser emission efficiency.

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REMARKS

Entry and consideration of this Amendment is respectfully requested.

Respectfully submitted,



Darryl Mexic
Registration No. 23,063

SUGHRUE MION, PLLC
2100 Pennsylvania Avenue, N.W.
Washington, D.C. 20037-3213
Telephone: (202) 293-7060
Facsimile: (202) 293-7860
DM/tmm
Date: January 28, 2002

20020128 10:00 AM

APPENDIX

VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE SPECIFICATION:

The specification is changed as follows:

Page 2, paragraph bridging pages 1 and 2:

Fig. 9 is a schematic diagram showing a structure of a portion where the solid laser medium (hereinafter referred to as a laser medium, as needed) 2 is excited by the laser diode 1. A plurality of laser diodes 1 (1a, 1b, 1c and 1d) are connected in series to a direct current power source 10, and apply excitation light to the cylindrical laser medium 2 via a light guide 11. The excitation light may be applied directly to the laser medium [4] 2 without using the light guide 11. Since a current is used to control the output of the laser diode 1, a direct current power source for controlling the current is frequently employed as the direct current power source 10.

Page 5 second full paragraph:

According to the present invention, there is provided a solid-state laser diode comprising:

- a laser diode for exciting a solid laser medium;
- a constant current source for supplying a constant current to the laser diode;
- voltage measurement [means] unit for measuring a voltage at both ends of the laser diode; and
- abnormality detection [means] unit for detecting an abnormality at the laser diode based on an output of the voltage measurement [means] unit.

Page 6, first full paragraph:

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Further, according to the present invention, there is provided a solid-state laser device comprising:

a plurality of laser diodes connected in series, for exciting a solid laser medium;

a constant current source for supplying a constant current to the laser diodes;

voltage measurement [means] unit for measuring the voltage at both ends of the laser diodes; and

abnormality detection [means] unit for detecting an abnormality at the laser diodes based on the output of the voltage measurement [means] unit.

Page 7, first full paragraph:

In addition, according to the present invention, there is provided the solid-state laser device, wherein when n (n is a natural number equal to or greater than four) laser diodes are connected, the voltage measurement [means] unit measures the voltages of sets including m laser diodes (m is a natural number smaller than n) individually to output the voltages to abnormality detection [means] unit.

Page 7, third full paragraph:

Furthermore, according to the present invention, there is provided the solid-state laser device, wherein a normal range having a finite width defined an upper limit value and a lower limit value as reference values of the voltage for determining abnormality of the laser diode is set; and when the voltages at the laser diodes measured by the voltage measurement [means] unit are equal to or higher than the upper limit value or equal to or lower than the lower limit value, the abnormality detection [means] unit outputs an abnormality detection signal.

Page 8, second full paragraph:

Moreover, according to the present invention, there is provided the solid-state laser device further comprising:

reference value change [means] unit for changing the normal range for the measured voltage set at the abnormality detection [means] unit on a basis of an input current value.

Page 10, paragraph bridging pages 9 and 10:

Fig. 1 is a diagram showing a structure of an essential portion of a solid-state laser device according to a first embodiment of the present invention. A laser diode 1 is connected to a direct-current power source 10. Excitation light emitted from the laser diode 1 is applied to a solid-state laser medium 2. Further, a wiring for measuring the voltage of the laser diode 1 is installed in the laser diode 1 and the voltage of the laser diode 1 is measured by a voltage measurement unit 12. The voltage measured by the voltage measurement unit 12 is transmitted to a fault determination unit 13, which is as an abnormality detection [means] unit, to be compared with an upper limit value and a lower limit value that are set in advance. When being determined a fault, the fault determination unit 13 outputs a fault signal.

Page 18, paragraph bridging pages 17 and 18:

Fig. 6 is a schematic diagram showing a structure of the fault determination unit when the voltage range for a determination of normality varies depending on an input current. The voltage at the laser diode 1 is changed depending on the current flow. At a fault determination unit 43 in Fig. 6, based on the value of the input current, the upper limit value V2 to be input to an upper voltage limit comparison unit 43a and the lower limit value V1 to be input to a lower voltage comparison unit 43b are changed by an upper limit value change operation unit 43c and a

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lower limit value change operation unit 43d, which are reference value change [means] unit,

respectively. In this case, the voltage range for the determination of normality is shown in Fig.

7.

IN THE CLAIMS:

The claims are amended as follows:

1. (Amended) A solid-state laser diode comprising:

a laser diode for exciting a solid laser medium;

a constant current source for supplying a constant current to the laser diode;

voltage measurement [means] unit for measuring a voltage at both ends of the laser diode; and

abnormality detection [means] unit for detecting an abnormality at the laser diode based on an output of the voltage measurement means.

2. (Amended) A solid-state laser device comprising:

a plurality of laser diodes connected in series, for exciting a solid laser medium;

a constant current source for supplying a constant current to the laser diodes;

voltage measurement [means] unit for measuring the voltage at both ends of the laser diodes; and

abnormality detection [means] unit for detecting an abnormality at the laser diodes based on the output of the voltage measurement [means] unit.

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3. (Amended) The solid-state laser device according to claim 2, wherein the voltage measurement [means] unit measures the voltage of the plurality of laser diodes individually to output the individual measured voltage to the abnormality detection [means] unit.

4. (Amended) The solid-state laser device according to claim 2, wherein when n (n is a natural number equal to or greater than four) laser diodes are connected, the voltage measurement [means] unit measures the voltages of sets including m laser diodes (m is a natural number smaller than n) individually to output the voltages to abnormality detection [means] unit.

5. (Amended) The solid-state laser device according to [one of claims 1 to 4] claim 1, wherein a normal range having a finite width defined an upper limit value and a lower limit value as reference values of the voltage for determining abnormality of the laser diode is set; and

when the voltages at the laser diodes measured by the voltage measurement [means] unit are equal to or higher than the upper limit value or equal to or lower than the lower limit value, the abnormality detection [means] unit outputs an abnormality detection signal.

6. (Amended) The solid-state laser device according to claim 5, further comprising:

reference value change [means] unit for changing the normal range for the measured voltage set at the abnormality detection means on a basis of an input current value.

IN THE ABSTRACT OF DISCLOSURE:

The abstract is changed as follows:

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According to the present invention, there is provided a solid-state laser diode comprising:

a laser diode for exciting a solid laser medium;

a constant current source for supplying a constant current to the laser diode;

voltage measurement [means] unit for measuring a voltage at both ends of the laser diode; and

abnormality detection [means] unit for detecting an abnormality at the laser diode based on an output of the voltage measurement [means] unit. Whereby a photodiode need not be arranged on the periphery of the solid laser medium and the laser diode, and an abnormality at the laser diode can be detected without increasing the size of the device and complicating the device and without deteriorating the laser emission efficiency.